II. Pseudacraca eurytus hobleyi, *its forms and its models on the islands of L. Victoria, and the bearing of the facts on the explanation of mimicry by Natural Selection.* By G. D. Hale Carpenter, M.B.E., D.M., F.L.S., F.E.S., F.Z.S., Uganda Medical Service.

[Read November 5th, 1919.]

Plates II, III.

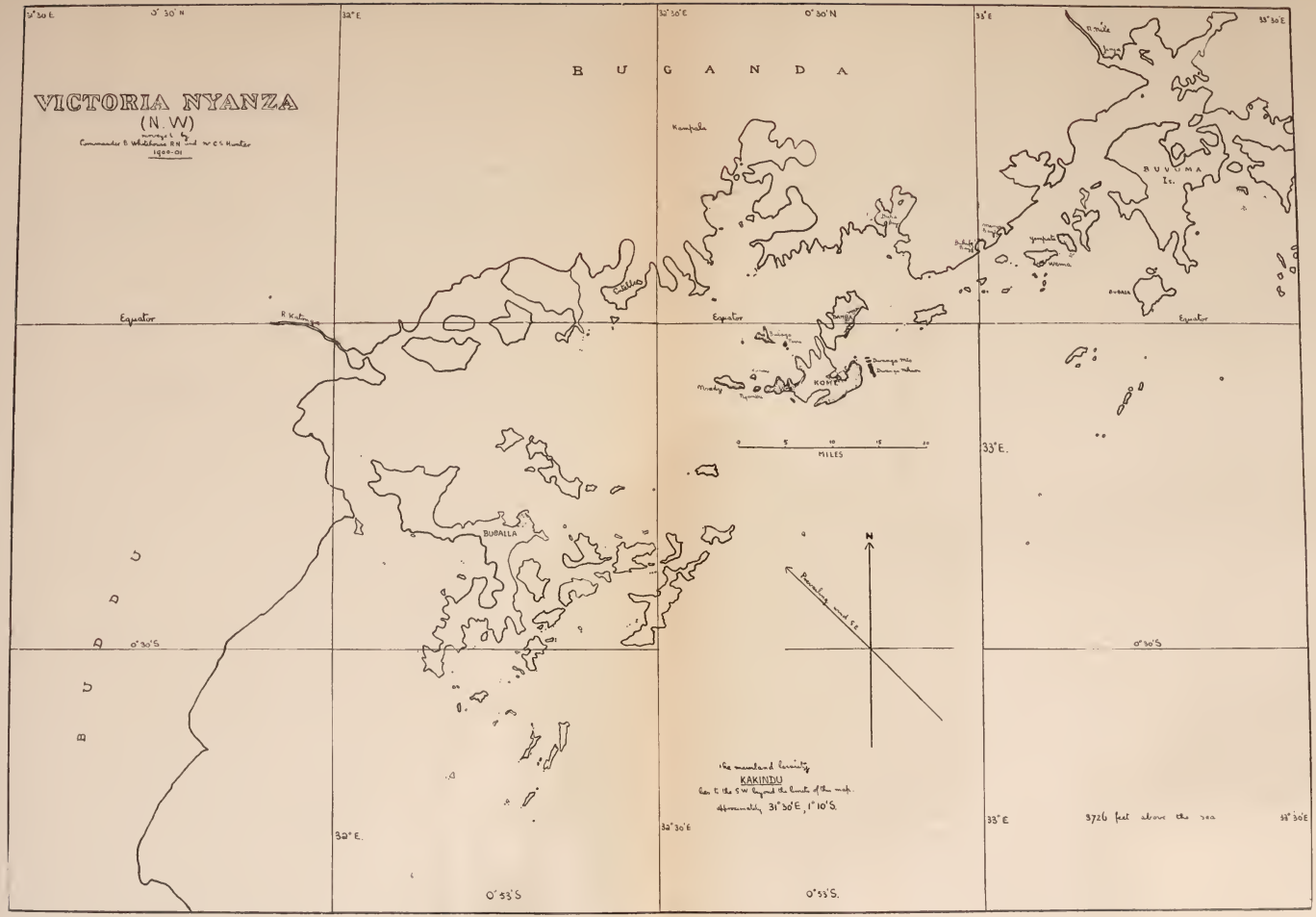
Forms of *Pseudacraca eurytus hobleyi* and its models were the subject of a paper which was communicated to the Society in November 1913, and was published in these Transactions, March 31, 1914, pp. 606–645.

The object of the paper was to show that with comparative scarcity of models on the islands, mimics which do not maintain the typically close resemblance are not destroyed by the action of natural selection (working, presumably, through vertebrate enemies), but are preserved; while in other places such as Entebbe on the mainland where models are more numerous than mimics the latter are kept true to type.

The explanation of the great number of varieties on the islands as compared with the mainland was first suggested to me by Prof. Poulton, as a result of a collection made on Damba island in 1911, which was described in Proc. Ent. Soc. 1911, pp. xci–xcv; 1912, pp. xxii–xxiii. Some of them were figured on Pl. xxxvi in the above-mentioned paper in 1914.

When I returned to the islands at the beginning of 1914 I went to a different group (see map), lying south of Entebbe and about twenty-five miles from it. Camp was pitched on the west end of the north shore of Kome, and the neighbouring small islands Bulago, Tavu, Ngamba, and Kimmi were frequently visited.

In August 1914 work was cut short by the call of active service, and during the rest of that year and in 1915 I was with troops on the Kagera river to the west of the lake. I spent many months at Kakindu (about 31° 30′ E., 1° 10′ S.), where was a fine forest known as the Tero forest, and here were obtained more specimens of the forms of *Pseudacraca eurytus* and their models.


VICTORIA NYANZA
(N. W)
Commander B. Middleton R.N. and W.C.S. Hunter
1900-01
B U G A N D A
Kampala
Equator
R. Kafu
BUGALLA
B U D D U
0° 30' S
0° 53' S
32° E.
32° 30' E
0° 30' N
33° E
33° 30' E
RUVUMA
Is.
KOME
MILES
33° E.
Prevailing wind S.E.
N
the mainland vicinity
KAKINDU
due E the S.W. beyond the limits of the map.
Approximately 31° 30' E, 1° 10' S.
3726 feet above the sea

Lastly, after the signing of the armistice I was enabled to return to work on the islands, and went back to Kome in Dec. 1918, where I obtained more specimens from the same localities as in 1914, and also from the *eastern* end of the large island of Kome.

The specimens obtained from these localities have afforded most interesting and important data, exactly complementary to those in the earlier paper. The figures given in that paper may be here reproduced, together with the new data now discussed.

	Planema models.	*Pseudacraea* (all forms).
Mainland, 1909 (C. A. Wiggins, Entebbe)	252	88
Bugalla Island, 1912–13 . . .	129*	356
Kome and neighbouring islands, 1914 .	440	78
Mainland (Kakindu), 1915 . . .	102	13
Kome and neighbouring islands, 1918–19	39	55
Sundry other islands, 1918–19 . .	3	38

Study of the present data shows that :—

I. In 1914 on the islands *Planema* models were found to be very numerous and the *Pseudacraea* mimics less abundant and true to type, as in the Wiggins collection from the mainland.

II. On individual islands the predominant form of *Pseudacraea* was that which mimics the predominant *Planema* of that locality.

III. The collection from the Tero forest on the mainland (Kakindu) confirms the last result. In this locality the only abundant form of *Planema* was copied by the appropriate form of *Pseudacraea*, while only a single specimen of another form was taken.

IV. On the same islands in 1918–19, *Pseudacraea* was again more numerous, and more variable.

V. A collection from sundry other islands in 1918–19 contains ten times as many *Pseudacraea* as *Planema* models, nearly half of which are transitional.

The total numbers for 1914 are tabulated below for comparison with the Bugalla captures: the former are indicated by ordinary figures, the latter by Roman figures.

* The total was wrongly added up to 127 in the description of the table in the 1914 paper.

Combination.	Models.	Forms of *Pseudacraea eurytus hobleyi* Neave.	Other mimics.
I A.	*Planema poggei nelsoni* Grose-Sm. ♂ II. 23 ♀ 0. 11	♀ forma mimetica *poggeoides* Poulton. II. 0	*Ps. kuenowi hypoxantha* Jord. ♂ III. 0 ♀ VI. 0 *Papilio dardanus* Brown. ♀ f. m. *planemoides* Trimen. I. 0
I B.	*Planema macarista* ♂ E. M. Sharpe. X. 70	♂ f. m. *hobleyi* Neave. XXVIII. 19	*Acraea alciope* Hew. ♀ f. m. *aurivillii* Staud. XI. 3 ♀ f. m. *alicia* Grose-Sm. approaching typical western form (I). 0 non-mimetic ♂ (V). 0 *Precis rauana* Grose-Sm. ♀ XXIII. 1 non-mimetic ♂ (XXIV). (5)
II.	*Planema macarista* ♀ VII. 18 *Planema alcinoe cumerunica* Auriv. ♀ II. 33. not mimicked ♂ (VIII). (107) *Planema aganice* Hew. form *montana* Butl. ♀ 0. 49 not mimicked ♂ 0. (85)	♀ f. m. *tirikensis* Neave. XL. 17.	*Acraea jodutta* F. ♀ f. m. *jodutta* F. III. 2 non-mimetic ♂ (III). 4
		Forms transitional between ♂ *hobleyi*, ♀ *tirikensis*, and ♂ ♀ *obscura* Neave. ♂ XXIII. 0 ♀ XXII. 1	
III.	*Planema epaea paragea* Grose-Sm. ♂ XLI. 0 ♀ XXXIV. 0	f. m. *obscura* ♂ VII. 1 ♀ XIX. 3	*Papilio cynorta* Fabr. ♀ f. m. *peculiaris* Neave. ♂ 0. 0 Non-mimetic (I). 0
		Forms transitional between ♂ ♀ *obscura* and ♂ ♀ *terra* Neave. ♂ XXVI. 0 ♀ XI. 2	
IV.	*Planema tellus cumelis* Jord. (*platyxantha* Jord.) ♂ XXIV. 185 ♀ IX. 51	f. m. *terra*. ♂ LVI. 19 ♀ XLVIII. 16	*Acraea jodutta* Fabr. ♀ f. m. *dorotheae* E. M. Sharpe. VI. 4
		Forms transitional between ♂ ♀ *terra* and ♂ *hobleyi* and ♀ *tirikensis*. ♂ XXXVI. 0 ♀ XXXVIII. 0	
Totals	CXXIX. 140	CCCLVI. 78	

The tables on pp. 88–90 give the numbers of the various species which are the subject of the paper, together with others belonging to the same combinations.

It is hardly necessary again to go through the four combinations of models and their mimics, as these were classified in the former paper.

Some points especially worthy of notice may, however, be mentioned.

Combination I.—The chief mimic in this group, *Pseudacraea kuenowi hypoxantha* Jord., was not very abundant on Bugalla island, neither is it at Entebbe. But it is quite absent from the collections which are the subject of this paper. The Papilionid mimic, form *planemoides* of *Papilio dardanus*, was only taken at Kakindu during the period under discussion, where it was the commonest form of female. This and other mimetic Papilios from Kakindu will, I hope, form the subject-matter of a future paper.

Combination I B.—The form *hobleyi* of *Ps. eurytus* shows considerable variation in the amount of white and orange on the hind-wing. The model, ♂ *Planema macarista*, usually has some orange bordering the white, and is often copied in this respect by specimens of *hobleyi*.

Acraea alciope is scarcer in these collections than in that from Bugalla.

Combination II.—A new member of this combination was found in abundance directly I arrived on Kome in 1914, namely *Planema aganice* Hew., form *montana* Butl. The male of this handsome species does not enter into any of the mimetic associations now under consideration, but its female is of the same type as that of *Planema macarista* E. M. Sharpe, and is figured with it. It is a very remarkable fact that, although so abundant on Kome in 1914, this species was never captured on Damba in 1911, where I spent nine months, and first made the acquaintance of the fascinating *Planema–Pseudacraea* combinations. Damba on its western side is only separated from Kome by a narrow channel of a few hundred yards! (see map). Equally interesting are the facts that it was never seen on Bugalla during fourteen months' residence in 1912–13, and only *one*, a male, appears in the large Wiggins collection made at Entebbe in 1909. But on looking through a collection that I made a little way east of Entebbe on the north shore of the lake in 1910 (Buka bay, see map), I found several examples of *Planema aganice montana*.

	Mainland (C. A. Wiggins) Entebbe, 1909.	Bugalla island, 1912–13.	Kome group of islands, 1914.					Mainland (Kakindu), 1915.	Kome island, 1918–19.	Sundry islands, 1918–19.
			Kome.	Bulago.	Ngamba.	Kimmi.	Tavu.			
Planema poggei nelsoni . . ♂	13	2	18	1	2	2		4	1	
,, ,, ,, . . ♀	1		7	1	1	1	1	6		2
,, *macarista* . . . ♂	84	10	31	7	20	12				
,, ,, . . . ♀	39	7	13	1	3	1				
,, *alcinoe camerunica* . ♀	11	2	23	2	3	2	3	4	2	
,, ,, ,, . . ♂	31	8	83	15	4	2	3	1	1	
,, *aganice montana* . . ♀			11	14	17	6	1	1	1	
,, ,, ,, . . ♂	1		24	20	23	17	1			1
,, *epaea paragea* . . ♂	12	41						10		
,, . ,, ,, . . ♀		34						6		
,, *tellus eumelis* . . ♂	78	24	184	1				27	21	1
,, ,, ,, . . ♀	14	9	51					44		
Acraea alciope, form *aurivillii* . ♀	51	11	2		1			6		
,, ,, ,, *alicia* . . ♀	2	1								
,, ,, ,, ,, . . ♂	39	5						7		
,, *jodutta*, form *jodutta* . ♀	47	3	2					9		
,, ,, ,, *dorotheae* . ♀	23	6	2		1	1		8		

Acraea jodutta chrysippus-like .	♀	4		1		1						
,, ,, ,, . .	♂	63	3	4				1	40			
,, *althoffi*, form *althoffi* .	♀	3										
,, ,, ,, *telloides* .	♀	8										
,, ,, ,, ,, . .	♂	14							1			
Pseudacraea eurytus, form *poggeoides*	♀	1	2									1
,, ,, ,, *hobleyi* .	♂	36	28	8		9	2		1	8		3
,, ,, ,, *tirikensis*	♀	33	40	8		7	2			5		8
,, ,, ,, *obscura*	♂		7	1						1		2
,, ,, ,, ,,	♀		19	1		2						2
,, ,, ,, *terra* .	♂	6	56	19					5	11		1
,, ,, ,, ,, .	♀	10	48	16					7	8		7
,, ,, transitional .	♂	1	85							13		7
,, ,, ,, .	♀	1	71	3						9		7
,, *kuenowi* . . .	♂	1	3									
,, ,, . . .	♀	1	6									
Precis rauana	♀	?	23	1					6			3
,, ,, ...	♂	?	24	2	3				9			
Elymnias phegea (white marked) .	♀	1										
Papilio dardanus, form *planemoides*	♀	6	1						10			
,, ,, ,, *niobe* .	♀	2							2			

? = number not given.

Date.	Locality.	Acraeine (*Planema*) models.												Acraeine mimics.										Nymphaline mimics.																Papilionine mimics.				Satyrine mimic.		Hypsid moth mimic.
		I.				II.						III.		IV.	*Acraea alciope.*		*Acraea jodutta.*			*Acraea althoffi.*				*Pseudacraea.*																*Precis rauana.*		*Papilio dardanus merope.*		*Papilio cynorta.*		*Elymnias phegea.*		*Deilemera acraeina.*
		A. *poggei nelsoni.*		B. *mwcristu.*		*mwcristu.*		*alcinoe camerunica.*		*aganice montana.*		*epaea paragea.*		*tellus eumelis.*	*aurivilii* mimics I.	non-mimetic.	*jodutta* mimics II.	*dorotheae* mimics IV.	non-mimetic.	*althoffi* mimics II.	*tellioides* mimics IV.	non-mimetic.	*poggeoides* mimics I. A.	*eurytus hobleyi.* mimics I. B.	*hobleyi* mimics II.	*tiriknesis* mimics III.	*obscura* mimics III.	*terra* mimic IV.	*kucnowi.* mimic I.		mimics I.	non-mimetic.	*plinnonides* mimics I.	*niobe* mimics IV.	*egnasia.*	*peculiaris* mimics III.	mimics I.	mimics II.	mimics II.
		♂	♀	♂	♀	♀	♂	♀	♂	♂	♀	♂	♀	♂ ♀	♀	♂	♀	♂	♂	♀	♀	♂	♀	♂	♀	♂	♀	♂ ♀	♂ ♀	♂	♀	♀	♂	♀	♂	♀	♀	♀	♀	♀						
1901	Damba Is.	2	1	1	1							4		7	+	+								1	5	4	3	15				+	+												
																								10 transitionals																					
1912–1913	Bngalla Is.	2	0	10	7	2	8					41	34	24	9	11	5	3	6	3				2	28	40	26	104		3	6	23	24	1											
																								156 transitionals																					
1914	Kome group of islands	23	11	70	18	33	107	49	85					185	51	3		2	4	5					19	17	4	35				1	5												
																								3 transitionals																					
1918–1919	Kome Is.	1				2	1	1						21											8	5	1	19																	
																								22 transitionals																					
1918–1919	Sundry islands		2							1				1										1	3	8	4	8				3												
																								14 transitionals																					
1909	Mainland (Entebbe) C. A. Wiggins	13	1	84	39	11	31			1		12		78	14	51	39	47	23	63	3	8	14	1	36	33		16		1	1	+	+	6	2		+		1	+
																								2 transitionals																					
1915	Mainland (Kakindu)	4	6			4		1				10	6	27	44	6	7	9	8	40			1		1			12				6	9	10	2	+				+
																								0 transitionals																					

Sign + indicates present, but numbers not given.

According to Eltringham's "African Mimetic Butterflies" the typical *aganice*, in which the male is paler and the female has the white areas of smaller extent, is "confined to the Natal region, and is represented in British and German East Africa by the variety *montana*, which has a much wider range, being common in the Belgian Congo."

An interesting point is that in 1914 when visiting a group of islands east of Kome (Wema, etc.) this *Planema* was not noticed there.

But in 1919 when revisiting all the islands I had been to in '14, I found *aganice* on the Wema group. I am quite inclined to think that it had arrived there since 1914.

The ♂ of *Planema alcinoe* sometimes shows strong suffusion of the brown near the base of the fore-wing by a dusky hue. If this were accentuated a distinct approach to the pattern of the ♂ *aganice montana* would be produced. This point requires further investigation.

A very interesting member of Combination II is the large black-and-white Hypsid moth *Deilemera acraeina* H. H. Druce. This occurs at Entebbe, but I had never found it until I collected at Kakindu, so that it does not seem to have made its way to the islands. It was noted in my journal that "I saw it on the wing and took it for another ♀ *Papilio cynorta* Fabr., but realised after a little that there was something different. Its flight was not like that of any Hypsid I have seen before; much more floating and like that of the *Papilio*." *P. cynorta* ♀ is black and white, mimicking the ♀ *Planema epaea* of the west coast, which shows minor differences in its pattern from the *Planema* models of Combination II.

Another member of Group II, the black-and-white form of the Satyrine *Elymnias phegea*, which is not common at Entebbe, has never been met with on an island, nor at Kakindu.

Combination III.—The model, *Planema epaea* Grose-Sm., in its eastern form *paragea* was not taken on any of the islands discussed in this paper, although it occurs on Damba, which, as has been said, lies only a few hundred yards away from the eastern end of Kome. But several were taken at Kakindu, showing considerable variation. It is very interesting that at Kakindu *Papilio cynorta*, which was very abundant, was entirely of the *western* form, whose female mimics the black-and-white western form of *Planema epaea* which was not seen at Kakindu.

On the other hand, a few of the eastern form of the model, form *paragea*, *were* taken at Kakindu.

So here is an example of eastern (*Planema*) and western (*Papilio*) forms commingling on the western side of the great lake, while the form *peculiaris* Neave, of the *Papilio*, corresponding to the eastern model, did not occur.

Combination IV.—The form *dorotheae* of *Acraea jodutta* mimics *Planema tellus*, the model of this group. Another form is the black-and-white *jodutta*, belonging to Combination II.

A very interesting form has the subapical white bar on the fore-wing, but the other areas are of the rich orange of *dorotheae;* this corresponds to the more southern *esebria*, one of which was taken at Kakindu on 29.4.15. There is a very interesting similar variety of *Pseudacraea eurytus* transitional from *terra* to *hobleyi;* the likeness to the *Acraea* is remarkable, and the likeness of both to *Danais chrysippus*. A single ♂ of *Acraea esebria* was taken at Kakindu, of the same type as the last-mentioned form of *jodutta*. According to Eltringham this is "essentially a S. African insect" ("African Mimetic Butterflies," p. 81); it is considered by him to be distinct from *jodutta* although closely allied.

Acraea althoffi, of whose non-mimetic male a single one was taken at Kakindu, is of much interest since it has two forms of female which occur at Entebbe, but not in any locality where I have collected. These forms are secondary mimics in Combinations II and IV through the *jodutta* and *dorotheae* forms of *A. jodutta*, which are their primary models (Poulton, Report of 1er Congrès International d'Entomologie, 1911, pp. 504–506).

Transitional forms of Pseudacraea eurytus.—In the Bugalla collection of 1912–13 there were 85 ♂, 71 ♀ specimens showing a transition between the several named forms, out of a total of 356. In the collection from Kome, and the adjacent small islands lying off its western end, made in 1914, there were only 3 ♀ transitional forms out of a total of 77.

At Kakindu there were no transitional forms out of 13, which is not remarkable, seeing that all save one were of the form *terra*, corresponding to the predominant model. In 1918–19, however, on Kome island there were 22 transitionals out of a total of 52 *Pseudacraea*.

The proportions of *Pseudacraea* to *Planema* models in these localities are :—

	Wiggins coll. (mainland) 1909.	Bugalla (island) 1912–13.	Kome group (islands) 1914.	Kakindu (mainland) 1915.	Kome group (islands) 1918–19.	Sundry islands 1918–19.
Planema . .	252	129	440	102	39	3
Pseudacraea :						
(total) .	88	356	78	13	55	38
(transitionals)	2	156	3	0	22	14

Concluding Remarks.

These figures speak for themselves, and the specimens are in the Hope Department at the Oxford University Museum for any one to see.

It may be justly claimed that the results of recent collections are complementary to the former. That is, in the presence of greater numbers of models the mimics are found to be true to type, but when they outnumber the models many transitional and other varieties are found.

It was claimed in the previous paper that natural selection afforded the explanation, and this is further supported by specimens from Kome, Ngamba, and Kimmi islands and from Kakindu on the mainland (see map).

Locality.	Combination I.	Combination II.	Combination III.	Combination IV.
Pl.	56	47		235
Kome, 1914 *Ps.*	8	8	2	35
Pl.	23	23		
Ngamba, 1914 *Ps.*	9	7	2	
Pl.	15	9		
Kimmi, 1914 *Ps.*	2	2		
Pl.	10	5	16	71
Kakindu, 1915 *Ps.*	1			12

Kome is a large island and, like Bugalla, has forest along its shores and in patches on the high ground in its centre. Ngamba and Kimmi are quite small islands both covered almost entirely with forest. They are all so close together that it would be absurd to account for differences between the proportions of forms of *Pseudacraea* by climatic conditions. At Kakindu is a large area of forest at very little elevation above the lake level, extending from the lake shore five-and-twenty miles inland.

Now, on Kimmi the only *Planema* models in 1914 were the species with black-and-white females of Combination II, and the male of one of them belonging to Combination I. The only forms of *Pseudacraea* were *hobleyi* and *tirikensis* mimicking these combinations. On Kome the orange *tellus* of Combination IV predominated, and *terra* was the most abundant form of *Pseudacraea*.

On Ngamba, however, members of Combinations I and II were the prevailing models and the mimics were in proportions accordingly, to such an extent that just as *Planema tellus* appeared to be absent so was *terra* its mimic! But at Kakindu *tellus* was very much the most abundant, and all the *Pseudacraea* save one were of the corresponding form.

But the most remarkable feature of the collections now discussed is the difference between the proportions of models and mimics on Kome island in 1914 and 1918–19. On the former occasion 338 *Planema* models were taken, and only 56 *Pseudacraea*, of which only 3 were transitional: the proportion of model to mimic being 6 to 1. In 1918–19, however, 25 *Planema* models were taken but 55 *Pseudacraea*, of which 23 were transitional; the proportion of model to mimic being 1 to 2·2.

This most interesting result seems to fall in almost too well with the others! It is supposed that on an island such as Ngamba the insectivorous birds spare mimics in Combination II but destroy the rest, while on Kome and at Kakindu they find the model of Combination IV so much more abundant that its mimics are more often spared. This, of course, presupposes that the bird population of an island stays there, and that birds from Ngamba do not cross to Kome to hunt. Although this may seem an extravagant theory yet a tour among many islands in 1914 showed that the bird fauna of adjacent isles does differ, and I pointed out in 1918, in reply to some remarks